RFsTomo1

Dual Band Satellite Tomography Receiver

Hardware Specification

The RFsTomo1 Dual Band Satellite Tomography Receiver is part of the RF-shamaanit Oy Scientific Radio generic platform family. The instrument is a self contained standalone system that is designed for superb RF performance, providing first class scientific data. By carefully adhering to the manufacturers instructions, the RFsTomo1 will provide the user with many years of reliable service.

Antenna

The circularly polarized VHF/UHF antenna is specially designed for reliable satellite reception under very harsh conditions. It is designed to be a portable, low maintenance and high reliability antenna for the RF-shmaanit Oy RFsTomo1 tomography receiver. The antenna is DC short circuited by design, giving good protection against low frequency energy and transients such as ESD static discharge, and lightning induced voltage spikes. The antenna system includes a pipe mast onto which the satellite tomography outdoor instrument cabinet is installed during commissioning.
The optional RFs Reverce Frequency Refrence GPSDO antenna is also installed on the common antenna structure.

RFsTomo1 Receiver Antenna Specification:

Type:	Trap Turnstile
Design:	Specifically for RFsTomo1 Satellite Tomography Receiver
Structure:	Lightweight, protected by composite radome
Design Objectives:	Following criteria accounted for in antenna design: low mass, ease of installation, bandwidth, wind load, efficiency, radiation pattern, ground effect, height above snow/ice/wildlife, low real estate, snow/ice buildup, vibration, appearance, long life, maintenance free operation
Elements:	2 * 2 elements
BW_{-3dB} bandwidth:	150 ±2 MHz, 400 ±3 MHz typical
Matching, VHF:	S_{11} typically better than -13 dB
Matching, UHF:	S_{11} typically better than -11 dB
Protection:	Galvanic short circuit
Radome diameter:	1005 mm
Radome height:	860 mm
Mast height:	2000 mm
Mast structure:	Galvanized steel tubing, 50 * 2,5mm

RFsTomo1 Receiver Power supply

The RFsTomo1 scientific receiver is supplied with a special Low Voltage iron core safety isolation transformer that gives very good protection against mains grid transients. Additionally, the transformer design does not generate Radio Frequency Interference to the very sensitive VHF/UHF satellite receiver itself or other nearby radio instruments. It is also possible to feed the RFsTomo1 instrument with a solar and/or wind charged battery system in remote locations where there is no power grid connectivity.

RfsTomo1 Power supply specification:

Design:	Iron core transformer, IP34 enclosure
Installation:	In dry, ventilated location
Input voltage:	230 Vac
Output voltage	12 Vac protection voltage (Low Voltage LoVo)
Instrument consumption:	~23 W, pf = 0.95, in preheating state
	~12 W, pf = 0.84, in normal state
Allowed LoVo loss:	Maximum allowed loss 4 V with a 20 W load
	(compliance with 100m 2*2,5mm^2 Cu)
Cabling:	3*2,5mm^2 recommended

RFsTomo1 Instrumentation

The instrument is designed with strict Radio Frequency Interference protection, far exceeding EMC standard requirements in order to not degrade the wideband riometer performance and to protect any other co-located radio instrumentation. The enclosure has dual EMC-shielding and incorporates extensive filtering and protection on all attached internal and external lines. The receiver proper is designed into a a compartmentalized shielded structure of machined aluminium.

Operating temperature:	-30 +40°C
Thermal control:	The instument incorporates cooling and heating solutions
Status LED's:	PWR OK
	LNA CH1 ON
	LNA CH2 ON
Data processing:	Data is processed in the on board CPU
Data transfer:	Final end product is transferred over the Internet for use
Physical Interface:	Optical Ethernet
Optical Fiber:	Supplied with 100 m optical fiber cable
Media Converter:	Converter to RJ45 (8P8C modular connector) included
	(to be installed in dry & warm location)
Extension:	The Media Converter Ethernet interface may be extended to
	LAN, 3/4G or WLAN devices of choice by the customer

RFsTomo1 RF Front End

RFsTomo1 RF Front End specifications

Input and output connectors:	Internally SMA(f), 50 Ω
VHF Bandwidth:	BW_{-3dB} ±2 MHz (typical)
UHF Bandwidth:	BW_{-3dB} ±4 MHz (typical)
Out of Band Rejection:	>70 dBr (typical), UHF 3. harmonic >60 dBr
Passband Ripple:	±1 dB (typical)
Gain:	Designed for optimum AD converter dynamic range
Control:	Preampifiers may be enabled/disabled independently (for e.g. remote verification)
Intercept Point:	Output TOI + 33 dBm (typical)
Compression point:	Output -1 dB compression point +15 dBm (typical)
VHF Noise Figure:	Max. 0.8 dB at Front End input, 0.7 dB typical
UHF Noise Figure:	Max. 0,9 dB at Front End input, 0.6 – 0.7 dB typical
Built In Test:	Continuous monitoring and housekeeping of instrument currents, voltages, internal and external temperatures

RFsTomo1 AD Conversion and Processing

Digitizer Specification

Digitizer:	4 channel RFs sampler
Resolution:	14 bits
Sample Rate:	125 MHz
Sample Clock:	Temperature Compensated TCXO
Clock Aging:	±2 ppm over first year, ±5 ppm over five years
Clock Jitter:	<100 fs typical
FPGA Processing:	Two ARM Cortex A9 with NEON SIMD & FPU cores
FPGA RAM:	1 GB
CPU:	ARM Cortex-A53 (ARMv8), 1.5 Quad Core CPU
CPU RAM:	2 GB
eMMc Storage:	32GB
Mass Memory:	500 GB SSD drive
Operating Sytem:	Linux
Local Control Port:	USB-UART control port on Post Processing Computer
RFS Reverse Frequency Standard:	(Option) RFsTomo1 may be augmented with a built-in GPSDO for RFs reverse referencing, providing very high frequency and sampling accuracy. Please contact the manufacturer for further detail and pricing.

RFsTomo1 Performance

The RFsTomo1 Scientific Receiver handles (samples/40 kHz etc.)

Satellite Tomography functionality

Time Stamping:	Post Processing Computer timing is over NTP
Typical accuracy:	NTP accuracy 0,1 ms (typical) over 100 Mb/s network

Warranty

Standard Warranty:	The standard warranty for RFsTomo1 is 1 year
Extended Service:	Extended Warranty is available, please contact manufacturer for quotation or special requirements

Service

Warranty Service:	Carried out at Pietarsaari or Padasjoki facilities
Calibration Service:	Calibration Service is available, please contact manufacturer for quotation or special requirements

Training

Training:	1 day training for 6 persons included
Facility:	Pietarsaari
Content:	Shipping, On-Site Survey, Installation, Commissioning, Maintenance, Service

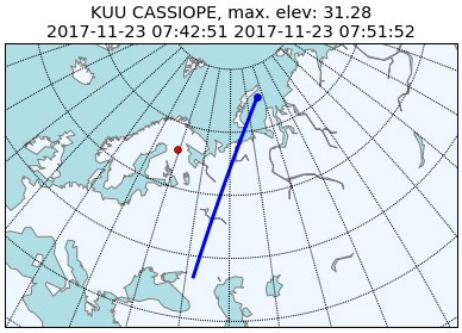
Improvements

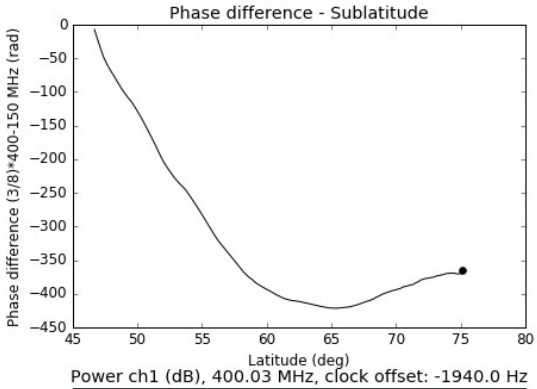
The manufacturer retains the right to improve the product without prior notice.

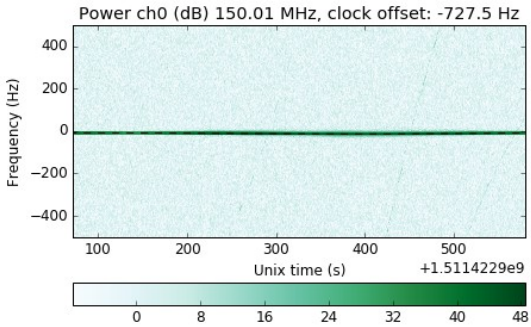
Typical Data

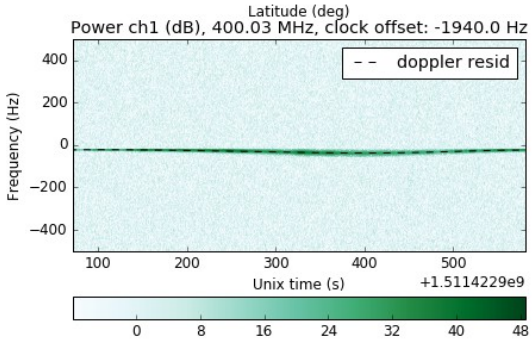
Overleaf is a typical RFs Satellite Tomography instrument data output providing data (Phase Curve) allowing calculation of ionospheric electron content and with multiple instruments, electron distribution. This particular plot is from an SGO receiver located in Kuusamo and the satellite received for this pass is Cassiope, that carries a coherent 150/400 MHz beacon pair.

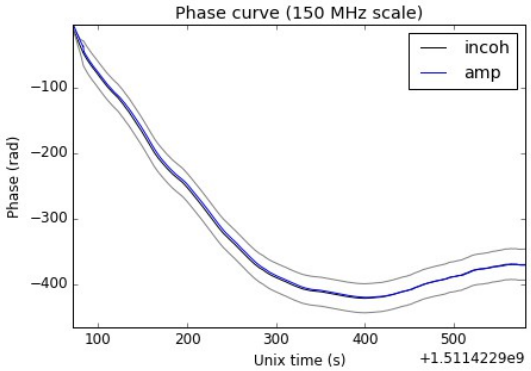
This data plot is generated with the GNU Ionospheric Tomography Receiver (Jitter) and is supplied with the delivered RFS Satellite Tomography instrument.

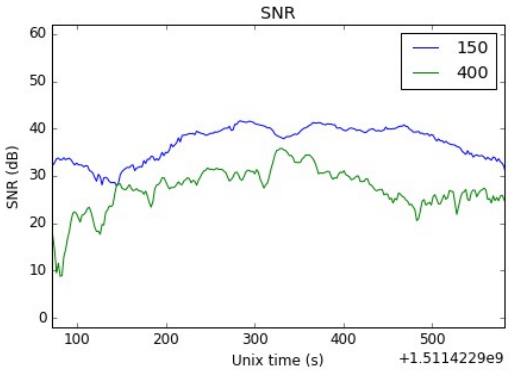

KUU CASSIOPE, max. elev: 31.28
2017-11-23 07:42:51 2017-11-23 07:51:52


Phase difference - Sublatitude
Phase difference (3/8)*400-150 MHz (rad)
Latitude (deg)


Power ch0 (dB) 150.01 MHz, clock offset: -727.5 Hz
Frequency (Hz)
Unix time (s)
+1.5114229e9


Power ch1 (dB), 400.03 MHz, clock offset: -1940.0 Hz
doppler resid
Frequency (Hz)
Unix time (s)
+1.5114229e9


Phase curve (150 MHz scale)
incoh
amp
Phase (rad)
Unix time (s)
+1.5114229e9


SNR
150
400
SNR (dB)
Unix time (s)
+1.5114229e9